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ABSTRACT

This document contains 30 units to consider for use in a tech prep competency profile for the occupation of electrical maintenance technician. All the units listed will not necessarily apply to every situation or tech prep consortium, nor will all the competencies within each unit be appropriate. Several units appear within each specific occupation and would need to only appear once if the user is compiling a cluster of occupations. The first three units are divided into subunits. These units (communications literacy, mathematics literacy, and science literacy) list the competencies for each subunit. The remaining units are divided into competencies, followed by a listing of competency builders. These units are as follows: technology literacy, employability skills, professionalism, teamwork, quality assurance, technical recording and reporting, computer literacy, workplace safety, basic electronics, fundamentals of electronics technology, troubleshooting and repair, microcomputer electronics technology, communications electronics technology, electro-optic technology, electronic product servicing technology, industrial electricity, electrical test and measurement equipment, wiring methods, drafting technology, computer-assisted drafting and design (CADD) fundamentals, equipment maintenance, electromechanical technology, fundamentals of machine anatomy, hydraulics and pneumatics, industrial manufacturing technology, programmable logic controllers, and computerized numerical control. (YLB)

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TECH PREP

"GET SERIOUS . . . ABOUT SUCCESS"

CE067902

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Electrical Maintenance Technician

Units to Consider: **Page**

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—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure

Competencies:

RS1 Exhibit knowledge of language structure
RS2 Recognize that there may be more than one interpretation of reading selections
RS3 Recognize various literary devices
RS4 Recognize and discuss literary elements
RS5 Develop and use an increasingly sophisticated vocabulary gained through context
RS6 Apply knowledge of language structure to reading
RS7 Explain why there may be more than one interpretation of reading selections
RS8 Recognize effect of literacy devices on meaning
RS9 Analyze author's use of literary elements
RS10 Recognize relationship of structure to meaning
RS11 Describe various interpretations and meaning levels in reading selections
RS12 Characterize author's use of literary devices
RS13 Characterize use of literary techniques
RS14 Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15 Apply an expanding vocabulary gained through reading
RS16 Explain various interpretations and meaning levels in reading selections
RS17 Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18 Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19 Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction

Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1	Select and read material for personal enjoyment and information
RA2	Read a variety of complete, unabridged works
RA3	Employ various reading strategies according to purpose
RA4	Participate in selection of books, materials, and topics for literature study groups
RA5	Develop and apply knowledge of the interrelationship of concepts
RA6	Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 of	Read extensively from a particular author's work and explain elements author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1	Connect themes and ideas across disciplines through literature
RM2	Read to facilitate learning across curriculum
RM3	Read to develop awareness of human rights and freedom
RM4	Participate actively in a community of learners
RM5	Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6	Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7	Value thinking and language of others
RM8	Relate literature to historical period about which or in which it was written
RM9	Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2 Clarify word choice according to audience, topic, and purpose
WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4 Recognize information gained from primary and secondary sources
WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6 Use information from a variety of sources to develop an integrated piece of writing
WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8 Recognize differences between documentation and reference list styles
WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11 Synthesize information from a variety of sources
WS12 Refine word choice and tone according to audience, situation, and purpose
WS13 Appropriately cite information gained from primary and secondary sources
WS14 Use style manuals or software to prepare documentation and reference lists
WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16 Identify organization patterns appropriate to writing topic
WS17 Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1 Apply appropriate writing techniques suitable for varied writing tasks

WA2 Use sentence-combining techniques to improve syntactic fluency and maturity

WA3 Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains

WA4 Develop personal voice in writing

WA5 Consider audience and purpose for writing

WA6 Develop criteria for selection and potential development of topic

WA7 Write in a journal or learning log to clarify personal thinking and knowledge

WA8 Apply an expanding vocabulary gained through writing

WA9 Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)

WA10 Demonstrate, an appreciation for aesthetically pleasing language through word choice and style

WA11 Apply revising and editing strategies needed for writing task

WA12 Vary sentence lengths and patterns

WA13 Refine personal voice in writing

WA14 Vary styles and formats for intended purpose and audience

WA15 Apply criteria for selection and development of topic

WA16 Participate in peer review of writing in progress

WA17 Use transitions between sentences, ideas, and paragraphs in writing

WA18 Revise and edit papers extensively in preparation for presentation/publication

WA19 Develop a variety of genres

WA20 Focus writing and tone on such elements as audience, situation, and purpose

WA21 Develop topic fully and appropriately

WA22 Use writing process to clarify personal thinking and knowledge

WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process

WA24 Develop an extended piece of writing

WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose

WA26 Use writing process to write reflectively

Subunit: Writing—Multidisciplinary
Competencies:

WM1 Use writing process for learning across curriculum
WM2 Use writing process to demonstrate knowledge of need for human rights and freedom
WM3 Value and apply collaborative skills in writing process
WM4 Write in response to reading, speaking, viewing, and listening
WM5 Use multidisciplinary resources in writing projects
WM6 Use writing process to facilitate learning across curriculum
WM7 Recognize value of and engage in collaboration in writing process
WM8 Use communication processes to develop a published writing piece in collaboration with others
WM9 Record experiences and observations related to content learning
WM10 Apply collaborative skills in writing process
WM11 Write collaboratively with peers
WM12 Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure
Competencies:

LS1 Listen to and view a wide variety of genres
LS2 Become aware of an author's style through listening and viewing a variety of works
LS3 Recognize correct and appropriate grammar, diction, and syntax
LS4 Expand vocabulary through listening to and viewing varied media
LS5 Recognize beauty of language
LS6 Enhance recognition of an author's style through listening and viewing a variety of works
LS7 Recognize use and misuse of language in media
LS8 Refine knowledge of style through listening and viewing multiple works by the same author
LS9 Expand and refine grammar, diction, and syntax through listening
LS10 Compare authors' styles through viewing and listening to their works
LS11 Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction
Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application
Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary
Competencies:

LM1	Facilitate learning across curriculum through critical listening and viewing
LM2	Engage in individual, small-group, and whole-group listening and viewing activities
LM3	Develop language arts (e.g., viewing, listening) projects collaboratively
LM4	Investigate language and cultural differences through listening and viewing activities
LM5	Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure
Competencies:

OS1	Refine oral communication skills
OS2	Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3	Select topics and vocabulary suitable to audience
OS4	Organize notes and ideas for speaking
OS5	Use language imaginatively
OS6	Modulate voice to meaning when interpreting literature orally
OS7	Organize notes and ideas for formal, semiformal and informal presentations of information
OS8	Refine speaking techniques for formal, semiformal, and informal settings
OS9	Develop repertoire of organizational strategies for presenting information orally
OS10	Expand vocabulary to fit topic
OS11	Select topics suitable to audience, situation, and purpose
OS12	Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1 Make connections between prior knowledge and new information for oral presentations
OM2 Participate in informal speaking activities
OM3 Use interviewing techniques to gather information
OM4 Communicate orally to entertain and to inform
OM5 Participate in group communication activities
OM6 Take and organize notes when preparing speech/presentation
OM7 Interpret texts orally to illustrate meaning
OM8 Respond to needs of various audiences
OM9 Gather and assess information for speaking
OM10 Communicate orally to inform and persuade
OM11 Prepare and deliver formal speech/presentation
OM12 Participate in a variety of oral interpretations
OM13 Assess needs of audience and adjust language and presentation according to their knowledge
OM14 Analyze and synthesize information for speaking
OM15 Describe effectiveness of literary selection
OM16 Describe topic or idea in order to clarify personal/audience thinking
OM17 Analyze and synthesize information gathered from a variety of sources for speaking
OM18 Describe validity and/or quality of a literary selection and justify selection
OM19 Interpret orally a variety of literature
OM20 Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1 Become proficient at using interviewing techniques
OA2 Give an oral interpretation for a specific audience
OA3 Develop and apply oral communication skills for cooperative/collaborative learning
OA4 Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5 Develop and apply decision-making strategies
OA6 Practice interviewing techniques
OA7 Apply interviewing techniques to purposeful interviews
OA8 Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1 Value thinking and language of others
OM2 Develop oral projects collaboratively
OM3 Be involved in individual, small-group, and whole-group language activities
OM4 Participate actively in a community of learners
OM5 Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)

Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation

Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability

Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2 Use language and notation of functions in symbolic and graphing settings
A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4 Describe and use logic of equivalence in working with equations, inequalities, and functions
A5 Develop graphical techniques of solution for problem situations involving functions
A6 Explore and describe characterizing features of functions
A7 Make arguments and proofs in algebraic settings
A8 Factor difference of two squares
A9 Identify slope, midpoint, and distance
A10 Explore and combine rational functions
A11 Explore factoring techniques
A12 Solve quadratic equations by factoring and formula
A13 Set up and solve linear equations
A14 Solve systems of linear equations with two variables
A15 Describe geometric situations and phenomena using variables, equations, and functions
A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17 Represent inequalities on number line and in coordinate plane
A18 Use coordinate arguments in making geometric proofs
A19 Symbolize transformations of figures and graphs
A20 Explore geometric basis for functions of trigonometry
A21 Graph linear functions
A22 Develop and use vectors to represent direction and magnitude including operations
A23 Use polar and parametric equations to describe, graph, and solve problem situations
A24 Represent sequences and series as functions both algebraically and graphically
A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26 Describe and solve algebraic situations with matrices
A27 Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30 Explore relationships between complex numbers and vectors
A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32 Represent transformations in plane with matrices
A33 Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34 Construct polynomial approximations of a function over specified intervals of convergence
A35 Examine complex numbers as zeros of functions
A36 Translate verbal statements into symbolic language
A37 Simplify algebraic expressions
A38 Use laws and exponents (including scientific notation)
A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41 Develop and communicate arguments about limit situations
A42 Use matrices to describe and apply transformations
A43 Develop and use polar and parametric equations to represent problem situations
A44 Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry

Competencies:

Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)

Q2 Use ratios, proportions, and probabilities in appropriate problem situations

Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)

Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations

Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies

Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations

Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions

Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)

Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding

Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information

Q11 Use appropriate units for counts and measures

Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations

Q13 Design and conduct investigations with multiple variables

Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)

Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science

Competencies:

C1 Participate actively in dialogue about and resolution of community issues
C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3 Analyze the scientific ideas presented in science fiction stories and films
C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5 Present the results of investigations in a variety of forums
C6 Contribute to the decisions regarding topics for investigation
C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8 Consider the scientific thinking and language of others
C9 Individually and collaboratively produce clearly written representations of investigative results
C10 Fulfill responsibilities as part of a research group
C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12 Present persuasive argument based on the scientific aspects of controversial issues
C13 Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14 Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15 Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16 Examine the intellect, perspectives, and ethics of notable scientists
C17 Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18 Create presentations of scientific understandings using diverse modes of expressions
C19 Conduct formal scientific debates in the classroom
C20 Wonder about the likelihood of events that may occur by chance or coincidence
C21 Plan and conduct field trips and experiences for small and large groups
C22 Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources

C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months

C25 Listen attentively and critically to presentations of scientific information made by others

C26 Conduct analyses of propaganda related to scientific issues

C27 Perform investigations that require observations over varying periods of time

C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists

C29 Access appropriate technology to perform complicated, time-consuming tasks

C30 Relate historical accounts of science to the cultural context in which they were written

C31 Work as a contributing member of a collaborative research group

C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues

C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas

C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)

C35 Lead groups of learners of various ages in designing, planning, and conducting science activities

C36 Respect the scientific thinking of others and self

C37 Recognize and contrast different epistemologies

C38 Develop possible courses of action in response to scientific issues of local and global concern

C39 Determine the validity of research conclusions in relation to the design, performance, and results

C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums

C41 Produce interesting and scientifically correct stories and present them using various modes of expression

C42 Reflect on the ideas and content found in their own journal records

C43 Examine ambiguous results and formulate explanations

C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1 Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases
A2 Make personal behavior decisions by interpreting information that has a scientific basis
A3 Propose courses of action that will validate and demonstrate personal understandings of scientific principles
A4 Guide other learners in their understanding of the interactions of technologies and society at various periods in time
A5 Promote and carry out practices that contribute to a sustainable environment
A6 Study and propose improvements in public services and systems in their community
A7 Choose consumer materials utilizing personal and environmental risk and benefit information
A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies
A9 Do simple trouble-shooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions
A10 Construct devices that perform simple, repetitive actions
A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)
A12 Make decisions regarding personal and public health
A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products
A14 Analyze the contributions of advances in technology through history to his/her everyday life
A15 Identify and reduce risks and threats to a sustainable environment
A16 Extend the limits of human capabilities using technological enhancements
A17 Use and recognize various propaganda techniques
A18 Solve unique problems using the results of systematic analyses
A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria
A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems
T2 Assess the career, family, and personal development implications of technological change
T3 Demonstrate continuous learning via technology
T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment
T5 Apply historical perspective on technology to the development and use of new technologies
T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems
T7 Apply legal principles and ethical conduct to the use of technology
T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems
T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities
T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities
T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective
T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: **Manage stressful situations**

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: **Analyze effects of family on work and work on family**

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: **Apply lifelong learning skills**

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: **Demonstrate knowledge of quality assurance**

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: **Demonstrate knowledge of quality cost implications**

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: **Demonstrate knowledge of engineering a quality product**

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: **Explain importance of interdepartmental relationships to quality assurance**

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: **Manipulate quality cost data**

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: **Manipulate cost control data**

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\bar{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\bar{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: Demonstrate knowledge of nondestructive testing

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: **Demonstrate knowledge of safety and workplace hazards**

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: **Explain purpose of industrial pollution control systems**

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Basic Electronics

Competency: **Demonstrate proficiency in electronics fundamentals**

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: Demonstrate proficiency in DC circuits

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: Demonstrate proficiency in AC circuits

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Competency: Demonstrate proficiency in C circuits (CONTINUED)

Competency Builders:

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Fundamentals of Electronics Technology

Competency: **Demonstrate proficiency in discrete solid-state devices**

Competency Builders:

Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors
    (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices
    (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Operate analog and digital equipment for solid-state devices
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers

Competency: Demonstrate proficiency in analog circuits

Competency Builders:

Operate measuring instruments for analog circuits
Describe operating characteristics and applications of linear integrated circuits
Describe operating characteristics and applications of power supplies and filters
Describe operating characteristics and applications of operational amplifier circuits
Demonstrate the operation of operational amplifier circuits
Describe the operating characteristics and applications of regulated and switching power supply circuits
Demonstrate the operation of regulated power supply circuits
Describe operating characteristics and applications of active filters
Demonstrate the operation of active filter circuits
Describe operating characteristics and applications of sinusoidal and non-sinusoidal oscillator circuits
Demonstrate the operation of oscillator circuits
Describe the operating characteristics and applications of motor phase-shift control circuits (single-phase and multi-phase)
Describe the operating characteristics and applications of cathode ray tubes

Competency: Demonstrate proficiency in digital circuits

Competency Builders:

Operate logic problems for digital circuits
Operate power supplies for digital circuits
Operate pulsers for digital circuits
Operate oscilloscopes for digital circuits
Describe characteristics of integrated circuit (IC) logic families
Describe the principles and operation of types of logic gates and their truth tables
Demonstrate the use of logic gates
Describe the principles and operation of combinational logic circuits
Demonstrate the operation of combinational logic circuits
Describe the principles and operation of numbering systems, codes, and arithmetic operations
Minimize logic circuits using Boolean operations
Describe the principles and operation of types of flip-flops
Demonstrate the operation of flip-flops
Describe the principles and operation of types of registers and counters
Demonstrate the operation of registers and counters
Describe the principles and operation of clock and timing circuits
Demonstrate the operation of clock and timing circuits
Describe the principles and operation of types of arithmetic-logic circuits
Demonstrate the operation of arithmetic-logic circuits
Describe the principles and operation of types of encoders and decoders
Demonstrate the operation of encoders and decoders
Describe the principles and operation of types of multiplexer and demultiplexer circuits
Demonstrate the operation of multiplexer and demultiplexer circuits
Describe the principles and operation of digital-to-analog and analog-to-digital circuits
Demonstrate the operation of digital-to-analog and analog-to-digital circuits
Describe the principles and operation of types of digital display circuits
Demonstrate the operation of digital display circuits
Describe the types of digital display devices
Demonstrate the operation of digital display devices
Describe the operating characteristics and applications of fiber optics
Demonstrate the operation of fiber optics

Competency: **Demonstrate basic proficiency in microprocessors**

Competency Builders:

Describe the essential components of a microprocessor and their functions
Identify the levels of computer languages
Operate oscilloscopes and logic/data analyzers
Describe the principles and operation of BUS concepts
Describe the principles and operation of types of memory circuits
Demonstrate the operation of memory circuits
Troubleshoot memory circuits
Repair memory circuits
Describe microprocessor instruction sets
Describe the principles and operation of microprocessor machine code
Demonstrate the use of microprocessor machine code
Debug microprocessor machine code
Interface various types of peripherals
Describe the use of microprocessor simulator(s)

Competency: **Describe manufacturing of electronic devices and micromechanisms**

Competency Builders:

List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: **Apply troubleshooting techniques to AC circuits**

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: **Apply troubleshooting techniques in discrete solid-state devices**

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: **Apply troubleshooting techniques to analog circuits**

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: **Apply troubleshooting techniques to digital circuits**

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: **Apply troubleshooting techniques to a microcomputer system**

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: **Apply troubleshooting techniques to manufacturing systems**

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Microcomputer Electronics Technology

Competency: **Demonstrate basic proficiency in microprocessor systems**

Competency Builders:

Describe essential components of microprocessor and their functions
Describe principles and operation of BUS concepts (e.g., VESA, EISA)
Describe principles and operation of types of memory circuits
Identify operating systems (e.g., DOS, OS/2, UNIX)
Describe microprocessor instructions sets
Describe principles and operation of microprocessor machine code
Demonstrate use of microprocessor machine code
Decode microprocessor machine code
Identify types of input and output devices and peripherals
Describe principles and operation of storage devices
Operate oscilloscopes and logic/data analyzers
Interface input and output ports to peripherals
Demonstrate ability to interface peripherals
Identify central processing unit building blocks and their uses
Identify the levels of computer languages

Competency: **Demonstrate basic proficiency in computer systems architecture**

Competency Builders:

Describe the principles and operation of computer system architecture
Operate computer system architecture
Repair computer system architecture
Describe the principles and operation of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Repair or replace volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Define individual system blocks
Draw systems configuration in block detail
Interpret computer acronyms
Describe priorities and interrupts at systems level
Identify direct memory access data handling system(s)
Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
Troubleshoot a microcomputer system

Competency: **Demonstrate proficiency in software fundamentals**

Competency Builders:

Load operating system software
Run operating system software
Load diagnostic software
Run diagnostic software
Construct flow charts
Analyze flow charts
Explain computer languages and their uses
Write a simple computer program
Write program documentation
Describe firmware applications
Identify the need for backup
Describe security measures
Describe virus protection

Competency: Describe elements of communication interfacing

Competency Builders:

Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485; IEEE 488)
Identify sync devices
Identify async devices
Identify types of network (e.g., token ring, ethernet)
Identify networking levels or layers
Identify protocols
Identify packet switching
Identify multiuser systems
Operate network analyze devices
Identify network analyzer devices (e.g., breakout bos, sniffers)

Competency: Describe peripheral equipment interfaces

Competency Builders:

Identify types of card and paper-tape equipment and interface controllers
Define printer types and interface controllers
Explain the operation of typical magnetic tape equipment and interface controllers
Identify disk equipment and interface controllers
Define environmental requirements for peripherals and media

Unit: Communications Electronics Technology

Competency: Describe transmission line applications

Competency Builders:

Explain power conversion
Describe principles and operation of two wire and four wire transmission lines
Describe principles and operation of coaxial cable
Describe principles and operation of microwave guide
Describe principles and operation of fiber optics

Competency: Demonstrate proficiency in transmitters and receivers

Competency Builders:

Explain the purpose of Federal Communication Commission (FCC) rules and regulations
Describe principles and operation of RF amplifiers
Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, Fiber optic, DSSC)
Construct modulation/demodulation
Operate modulation/demodulation
Describe principles and operation of microwave and satellite communication systems
Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)

Competency: Describe various types of multiplexing systems

Competency Builders:

Describe principles and operation of analog multiplexing systems (e.g., CATV)
Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)
Describe principles and operation of CRT modulation

Competency: **Troubleshoot transmitters and receivers**

Competency Builders:

Isolate system faults in RF amplifiers
Isolate system faults in CRT modulation/demodulation circuits
Isolate system faults in RF transmitters and receivers
Isolate system faults in television modulation circuits

Competency: **Demonstrate basic proficiency in data communications**

Competency Builders:

Describe principles and operation of data communications, signaling systems, codes, formats and protocols
Describe principles and operation of parallel and serial ports
Describe principles and operation of synchronous and asynchronous signals
Describe principles and operation of data modems
Operate data modems
Describe principles and operation of fax machines
Describe principles and operation of types of carrier systems
Describe principles and operation of various types of networks (e.g., ethernet, token ring)
Demonstrate operation of various types of networks
Describe proper techniques for cable termination (e.g., UTP, COAX, FIBER)
Demonstrate proper techniques for cable termination

Competency: **Troubleshoot data communications**

Competency Builders:

Isolate system faults in data modems
Isolate system faults in various types of networks
Isolate system faults in various types of cable
Isolate system faults in various types of carrier systems

Competency: Demonstrate basic proficiency in fiber optic communications systems

Competency Builders:

Describe proper techniques for fiber splicing
Demonstrate proper techniques for fiber splicing
Demonstrate techniques for fiber termination
Describe basic characteristics of optics such as reflection, total reflection, and refraction
Describe characteristics and components of fiber optic cables
Describe band width and attenuation limitations for fiber optic systems
Describe technique of wavelength multiplexing in fiber optic cables
Describe characteristics of various types of light sources and light detectors used in fiber optic systems
Describe components of fiber optic transmission systems
Describe transformation of data signals into light pulses
Operate a simple fiber optic data transmission system
Describe proper techniques of fiber termination

Competency: Demonstrate proficiency in RF systems safety

Competency Builders:

Demonstrate safety procedures for working with RF systems antennae and support structures (e.g., towers)
Demonstrate safety procedures for working with RF systems high voltage/power supply
Demonstrate safety procedures for working with RF generators
Demonstrate safety procedures for working with RF systems in confined space

Competency: Demonstrate basic proficiency in antenna systems

Competency Builders:

Describe the principles and operation of single element antennae (e.g., 1/4 wave dipole, longwire, vertical)
Describe the principles and operation of multi-element antennae (e.g., point-to-point, broadcast)
Describe the principles and operation of impedance matching of antennae systems
Describe antennae systems measurement
Operate antennae

Unit: Electro-optic Technology

Competency: Demonstrate knowledge of light principles

Competency Builders:

Describe the characteristics of light sources
Describe radiometric and photometric quantities in the measurement of light using light meters and related equipment
Describe the properties of light
Demonstrate the properties of light
Describe maximum permissible exposure (MPE)

Competency: Demonstrate knowledge of optical systems

Competency Builders:

Describe the characteristics and properties of optical materials
Describe the use of optical components (e.g., lenses, beam splitters)
Describe the principles and operation of optical systems (e.g., ray tracing, refraction)
Demonstrate the use of optical systems (e.g., convergence, focusing, divergence)
Troubleshoot optical systems
Describe the advantages and disadvantages of fiber optics

Competency: Demonstrate knowledge of lasers

Competency Builders:

Describe the principles of laser operations (e.g., population inversion, coherence)
Describe laser classifications
Describe the principles and operation of powering and pumping lasers
Describe temporal characteristics
Describe spatial characteristics
Describe laser safety

Competency: Describe laser energy applications

Competency Builders:

Describe the principles and operation of ion lasers
Describe the principles and operation of solid lasers
Describe the principles and operation of semiconductor lasers
Describe the principles and operation of dye lasers
Describe the principles and operation of lasers in welding, cutting, and drilling
Describe the principles and operation of lasers in data recordings and manipulating
Describe the principles and operation of lasers in environmental testing and monitoring
Describe the principles and operation of lasers in nondestructive testing
Describe the principles and operation of lasers in range finding, alignment and angle testing
Describe the principles and operation of fiber optics in laser systems
Describe the principles and operation of a laser in a communication system
Describe the advantages and disadvantages of fiber optics
Describe the principles of using lasers in medicine
Describe the principles of using lasers in holography/interferometry

Competency: Perform laser applications

Competency Builders:

Demonstrate the operation of various ion lasers
Demonstrate the operation of solid lasers
Demonstrate the operation of semiconductor lasers
Demonstrate the operation of dye lasers
Demonstrate CW and pulsed operation
Demonstrate the use of lasers in welding, cutting, and drilling
Demonstrate the use of lasers in data recording and manipulating
Demonstrate the use of lasers in environmental testing and monitoring
Demonstrate the use of lasers in nondestructive testing
Demonstrate the use of lasers in range finding, alignment and angle testing
Demonstrate the use of a laser communication system
Troubleshoot laser applications
Repair laser applications

Unit: Electronic Product Servicing Technology

Competency: Demonstrate proficiency in surface mounted devices

Competency Builders:

Describe the principles and operation of types of surface mounted devices (SMDs) for DC, AC and solid-state circuits
Describe the proper procedure for handling static sensitive devices
Locate defective SMDs using appropriate troubleshooting techniques
Replace SMDs using appropriate troubleshooting techniques

Competency: Demonstrate proficiency in radio and television receiving systems

Competency Builders:

Interpret radio and television receiving system block diagrams
Describe the principles and operation of a superhetrodyne receiver
Construct a superhetrodyne receiver
Align a superhetrodyne receiver
Troubleshoot a superhetrodyne receiver
Repair a superhetrodyne receiver
Describe the principles of video signal generation
Describe the principles and operation of TV circuits
Troubleshoot TV circuits
Repair TV circuits
Perform operating systems check to radio and television receiving systems
Adjust radio and television systems
Describe High Definition Television systems
Operate video analyzers
Operate National Television Signal Codes (NTSC) generators
Operate cathode ray tube (CRT) analyzers
Operate stereo generators

Competency: **Demonstrate proficiency in video recording and playback systems**

Competency Builders:

Describe characteristics associated with recording and playback systems
Interpret video recording system block and circuit diagrams
Identify operational status of video recording systems (mechanical and electronic)
Perform operating systems check to video recording systems
Adjust video recording systems
Describe the operating characteristics and application of BETA, VHS and 8mm test equipment
Demonstrate the operating characteristics and application of BETA, VHS and 8mm test equipment
Operate vectorscopes and wave form monitors
Describe the operating characteristics and application of BETA, VHS and 8mm recorders and playback systems
Describe the operating characteristics and application of camcorders
Demonstrate the operating characteristics and application of camcorders
Troubleshoot video recording systems
Repair video recording systems
Describe electronic chemicals (e.g., solvents, lubricants, anticorrosives)

Competency: **Demonstrate proficiency in laser disc systems**

Competency Builders:

Describe characteristics associated with laser disc systems
Interpret laser disc system blocks and circuit diagrams
Describe the operation of laser disc systems
Demonstrate the operation of laser disc systems
Describe the principles and operation of interactive video
Troubleshoot laser disc systems
Repair laser disc systems

Demonstrate proficiency in computer systems

Competency Builders:

Describe the principles and operation of computer system architecture
Demonstrate the operation of computer system architecture
Describe the principles and operation of addresses and interrupts
Demonstrate the use of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Demonstrate the use of advanced memory techniques
Troubleshoot computer systems
Repair computer systems

Competency: Demonstrate proficiency in home electronics systems

Competency Builders:

Describe characteristics associated with home automation systems (e.g., computers and peripherals)
Interpret home automation systems block and circuit diagrams
Describe the operation of home automation systems
Replace home automation systems
Describe the principles and operation of fax machines
Demonstrate the operation of fax machines
Describe the principles and operation of personal computer games
Demonstrate the operation of personal computer games
Describe characteristics associated with electronic security systems
Describe the installation of an electronic security systems
Demonstrate the operation of electronic security systems
Troubleshoot home electronics systems
Repair home electronics systems (e.g., replace and align electronic components)

Competency: **Demonstrate proficiency in audio systems**

Competency Builders:

Describe the principles and operation of audio systems
Interpret audio systems block and circuit diagrams
Demonstrate the operation of audio systems
Describe the principles and operation of digital audio tape (DAT)
Describe the principles and operation of digital compact cassette (DCC)
Troubleshoot audio systems
Repair audio systems (e.g., replace audio components)

Competency: **Demonstrate proficiency in antenna systems (CATV/SATV)**

Competency Builders:

Describe the principles and operation of antennae systems
Demonstrate the installation of antenna systems
Describe the principles and operation of a CATV system
Demonstrate the operation of a CATV system
Describe the principles and operation of a SATV system
Demonstrate the operation of a SATV system
Troubleshoot antenna systems
Repair antenna systems (e.g., replace and align antenna components)

Unit: Industrial Electricity

Competency: **Explain basic industrial electricity theory**

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: **Use the National Electrical Code (NEC)**

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: **Explain operation of electrical distribution systems**

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: **Demonstrate proficiency in direct current (DC) circuits**

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: **Demonstrate proficiency in alternating current (AC) circuits**

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Electrical Test and Measurement Equipment

Competency: **Demonstrate proficient use of electrical test equipment**

Competency Builders:

Describe function and operation of logic probe and logic analyzer
Describe function and operation of power monitor
Describe function and operation of signal generator
Describe function and operation of spectrum analyzer
Describe function and operation of AC/DC hi-pot
Describe function and operation of time-domain reflectometer (TDR)
Describe function and operation of megger
Describe function and operation of curve tracer/analogger
Apply test equipment to DC circuits
Apply test equipment to AC circuits
Apply test equipment to solid-state devices
Apply test equipment to digital circuits
Apply test equipment to analog circuits
Apply test equipment to microprocessors

Competency: **Demonstrate proficient use of electrical measurement equipment**

Competency Builders:

Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of amp probe
Describe function and operation of oscilloscopes
Describe function and operation of operation of infrared heat sensor
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors

Unit: Wiring Methods

Competency: **Apply National Electrical Code (NEC) and National Fire Protection Act (NFPA) Regulations**

Competency Builders:

Use NEC and NFPA to identify correct materials
Use NEC and NFPA to identify correct methods
Use NEC and NFPA to identify correct applications
Use NEC and NFPA to identify correct safety procedures

Competency: **Explain circuit protectors**

Competency Builders:

Explain grounding/bonding methods
Explain ground-fault circuit interrupters
Explain overcurrent/short circuit protection
Explain thermal protective devices

Competency: Install wiring

Competency Builders:

Describe functions of permits and licensing requirements
Interpret prints
Verify on-site dimensions
Install electrical boxes and panels
Describe overhead and underground service
Calculate load size conductors
Identify proper color coding
Lay out conduit runs
Install rigid conduit
Install nonmetallic rigid conduit
Install cable trays
Install flexible conduit
Install liquid-tight flexible conduit
Pull conductors
Install ground bonding systems
Install various wire connectors
Inspect rough installation
Prepare for agency inspection
Install bus-duct(s), bus-plug(s), and bus-drop(s)

Competency: Finish wiring

Competency Builders:

Install plugs and switches
Test plugs and switches
Install fixtures
Test fixtures
Install overcurrent protection
Test overcurrent protection
Install ground-fault interrupters (GFI)
Test ground-fault interrupters (GFI)
Install circuit breakers
Test circuit breakers
Label circuit breakers
Update prints and schematics

Competency: Prepare for electrical/electromechanical equipment installation

Competency Builders:

Identify electrical requirements for equipment
Interpret NEC, NFPA, IEC, and state and local electrical codes
Identify a power distribution source/requirements
Interpret symbols
Interpret schematics/drawings
Prepare site

Competency: Install electrical/electromechanical equipment

Competency Builders:

Build control panel
Install electrical motor control systems
Install electrical motors
Install sensors and various input devices
Install energy-management systems (e.g., lighting, HVAC, load-shedding)
Test equipment and circuits
Connect power to equipment
Test power to equipment

Competency: Interpret schematics and diagrams

Competency Builders:

Identify circuit function
Interpret electrical symbols
Interpret block and ladder diagrams
Interpret schematics

Competency: Trace circuits to locate problems

Competency Builders:

Identify circuit type or subsystem
Locate specific circuits
Apply proper troubleshooting technique(s)

Competency: Maintain electrical systems

Competency Builders:

Diagnose failure
Explain root cause of failure
Review schematic or ladder diagram
Repair or replace defective electrical apparatus
Document corrective action needed or taken

Competency: Use soldering tools

Competency Builders:

Select appropriate soldering tools and supplies for job
Perform soldering and desoldering techniques (e.g., micro-miniature, standard)

Competency: Install Class II systems

Competency Builders:

Define Class II systems
Comply with local, state, and federal codes (e.g., NEC, NFPA)
Install communication system
Install control system
Install lighting system
Install security systems
Install energy management monitoring systems
Maintain systems
Verify system operation

Unit: Drafting Technology

Competency: **Apply basic drafting skills**

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly. angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: **Convert dimensions and tolerances**

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: Inspect machine systems

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: Perform machine maintenance

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: Maintain stationary equipment

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Electromechanical Technology

Competency: **Interpret electromechanical drawings**

Competency Builders:

Identify types of drawings and their applications
Transfer measurements
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

Competency: **Describe the operation of electronic sensors and transducers**

Competency Builders:

Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation

Competency: **Demonstrate proficiency in transducers (sensors) and instrumentation**

Competency Builders:

Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

Competency: **Demonstrate proficiency in power distribution systems**

Competency Builders:

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

Competency: **Demonstrate proficiency in power distribution equipment**

Competency Builders:

Describe power transformers
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

Competency: Demonstrate proficiency in motors and motor control

Competency Builders:

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops

Competency: Apply quality control techniques

Competency Builders:

Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

Competency: **Apply electromechanical maintenance management practices**

Competency Builders:

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

Unit: Fundamentals of Machine Anatomy

Competency: Interpret specifications for a machine

Competency Builders:

Identify power source
Identify power transmission
Identify hydraulic/pneumatic actuators
Identify materials
Identify fits/tolerances
Identify GD&T symbols
Identify safety factors
Participate in concurrent engineering
Demonstrate knowledge of print reading

Competency: Build a machine to specifications

Competency Builders:

Install hydraulic and pneumatic actuators
Troubleshoot hydraulic and pneumatic actuators
Install motors
Troubleshoot motors
Install sensors
Troubleshoot sensors
Install PLC's
Troubleshoot PLC's
Install industrial controls
Troubleshoot industrial controls
Install power distribution systems
Troubleshoot power distribution systems
Install brakes and clutches
Troubleshoot brakes and clutches
Install lubrication system
Troubleshoot lubrication system

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: **Maintain hydraulic system components**

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: **Maintain vacuum systems**

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Industrial Manufacturing Technology

Competency: Describe industrial manufacturing process

Competency Builders:

Demonstrate use and maintenance of personal protective equipment
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Draft preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process

Competency: Demonstrate knowledge of materials requirements planning

Competency Builders:

Define materials requirements planning
Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
Define master production schedule and bill of materials
Explain inventory carrying cost and economic order quantity
Describe the use of the computer in MRP
Calculate net requirements

Competency: Demonstrate knowledge of supply materials

Competency Builders:

Describe role of purchase requisitions
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

Competency: Demonstrate knowledge of plant layouts

Competency Builders:

Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout

Competency: Demonstrate knowledge of material flow

Competency Builders:

Describe importance of flexibility
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages and disadvantages of each pattern

Competency: Maintain quality control of materials handling

Competency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of post-production control

Competency Builders:

Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Analyze a manufacturing project

Competency Builders:

Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

Unit: Programmable Logic Controllers (PLCs)

Competency: Differentiate among process controls

Competency Builders:

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

Competency: Explain basic operation of PLCs

Competency Builders:

Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

Competency: Demonstrate use of PLCs

Competency Builders:

Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of (Graphic Programmable Panel) GPP
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

Competency: **Apply robot fundamentals**

Competency Builders:

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

Unit: Computerized Numerical Control (CNC)

Competency: Demonstrate knowledge of CNC

Competency Builders:

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Identify data input mediums
Explain the purpose of the post-processor
Define canned cycles
Identify computer memory types
Identify information stored relative to computer memory types
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

Competency: Perform preventive maintenance

Competency Builders:

Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment

Competency: Apply CNC operations

Competency Builders:

Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development

Competency: Prepare CNC program

Competency Builders:

Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using CAD/CAM package
Program machine using manual data input (MDI) process

Competency: Program CNC operations

Competency Builders:

Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates and surface feet per minute limitations
Turn intersection points into segments (i.e., defined in terms of points, lines, and circles)
Debug program

Competency: Load machine

Competency Builders:

Load program from MDI and off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

Competency: Operate CNC machine

Competency Builders:

Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

Competency: Manufacture workpiece (e.g., rectangular, round, angular)

Competency Builders:

Dry-run machine
Run part
Inspect part